Available online at www.sciencedirect.com

ScienceDirect

Procedia Social and Behavioral Sciences 8 (2010) 207–212

Procedia Social and Behavioral Sciences

International Conference on Mathematics Education Research 2010 (ICMER 2010)

Mathematics Tutoring and Student Success

Junalyn Navarra-Madsen[a,*], Paul Ingram[b,c]

[a,b]*Faculty of the Department of Mathematics and Computer Science, Texas Woman's University*

[c]*Coordinator of Mathematics and Technology Success Centre*

Abstract

Courses in tertiary level Science Technology, Engineering and Mathematics (STEM) are perceived by some students as time-consuming, tedious and difficult. The increasing "attrition rate" of this cohort of college students is usually attributed to several factors. Retention and intervention programs under the umbrella of student support services can be put in place to mitigate the worsening situation. Most universities and colleges offer tutoring as part of academic support. In this pilot study, we collected tutoring-related data. We focused mainly on mathematics majors and found unexpectedly that there is no difference in grades for mathematics majors who visited and did not visit the tutoring centre, i.e., there is no strong correlation between the number of hours spent in the tutoring centre and grades in the courses tutored in.

***Keywords*:** Retention; Completion rates; Tutoring; Success rates; Attitudes; Student support services

1. Introduction

A recent Higher Education Research Institute research brief highlighted the fact that even though the proportion of whites and underrepresented racial minorities (URM) interested in STEM fields has converged over the past 4 decades, their completion rates have continued to diverge. The attrition rates for STEM majors are high, and they are highest for URMs. What can be done to help these students finish STEM bachelor degrees? In order to help with retention of these students, universities and colleges offer free tutoring support to all students. This practice is especially true when it comes to STEM courses. This paper focuses on one program intervention, STEM tutoring, in particular mathematics tutoring. The kind of tutoring involved in this paper is the so called "drop-in tutoring". Topping labelled this type of tutoring as dyadic cross-year fixed-role peer tutoring. Some research studies claim that tutoring increases mastery of academic skills, boosts confidence and self-esteem, enhances love of learning, and improves course and degree completion. Others claim otherwise. In order to help resolve these conflicting views about tutoring, there is a need to (1) formulate measurable objectives and outcomes, (2) plan carefully the data collection process, and (3) evaluate each step of the way. This paper is a work in progress that will longitudinally pinpoint important factors affecting success or failure in mathematics tutoring and STEM courses tutoring in general.

* Corresponding author. Tel.: +0-940-898-2168; fax: +0-940-898-2179.
E-mail address: jnavarramadsen@mail.twu.edu.

1877-0428 © 2010 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
doi:10.1016/j.sbspro.2010.12.028

2. Objectives

Most tutoring services are closely supervised by one or two STEM departments. To monitor these student support services, some quantitative data are gathered to help improve the tutoring program. In this current study, data gathered in the Mathematics and Technology Success Centre (MTSC) and institutional data obtained via the university reporting system for four semesters (Fall 2008, Spring 2009, Fall 2009, and Spring 2010) will be analyzed. Unlike other tutoring support programs which only offer tutoring for freshmen or sophomore level courses for retention purposes, MTSC offers tutoring in all mathematics courses ranging from developmental to graduate level mathematics. In this study, we focus on the undergraduate mathematics tutoring provided by MTSC. The following objectives of this study are:

1. To identify mathematics courses with the most number of visits in the MTSC.
2. To compare grades of mathematics majors (availed tutoring services and those who did not).
3. To study whether number of hours spent in the MTSC is directly correlated to the grades of mathematics majors in a course tutored in.

3. Methodology

During the academic year, tutoring facilities such as MTSC, Science Learning Centre, and the Write Site at Texas Woman's University (TWU) collect data such as students who self-select to avail tutoring services, number of times each student visits, what courses they need help with, who their instructors are in these courses and for how long they stay for tutoring. The tutoring facility's coordinator then emails a summary of this set of data to faculty on a weekly basis. In this study, we concentrate on MTSC data. The data during Fall 2008 and Spring 2009 were manually entered by student assistants while the data for Fall 2009 and Spring 2010 were collected via computerized user interface by students visiting. The following were the steps taken in designing this study:

- counted the total number of undergraduate students tutored for each semester;
- separated the mathematics majors who visited MTSC;
- tallied the total number of mathematics majors who requested tutoring for each mathematics course offered each semester;
- tallied the total number of visits and corresponding number of hours;
- gathered grades for each individual mathematics major who visited or not visited MTSC.
- zoomed in and narrowed down our study to two courses offered every semester for four semesters: Calculus I and Abstract Algebra;
- compared average grades of students who visited MTSC and those who did not; and
- utilized Pearson Product Moment Correlation Coefficient (r) to gauge correlation between amount of time spent at MTSC and grades in courses tutored in.

4. Findings

We described in Section 4.1 the overview of MTSC clientele. In Section 4.2, we looked at each mathematics course and check how many of the mathematics majors visited MTSC for specific mathematics course tutoring. In Sections 4.3 and 4.4, we examined the grades of mathematics majors who visited or not visited MTSC. In order to see whether there is correlation between number of hours spent at MTSC and grades of mathematics majors, we considered two specific mathematics courses offered every semester (Calculus I and Abstract Algebra).

4.1 Overview of MTSC Clientele

In order to measure how many undergraduate students availed MTSC tutoring services, we took the total number of students who visited MTSC (one or more times) and divided by the total number of undergraduate students enrolled in all mathematics courses each semester in the Denton campus only. Table 1 shows percentages of undergraduate students and mathematics majors visiting MTSC. On average, almost 30% of undergraduate students and 36% of mathematics majors availed services from MTSC. Forty-eight percent of mathematics majors have been visiting the last two semesters.

Table 1. Overview of MTSC Clientele (Fractions of Students Availing Tutoring Services)

SEMESTER	PERCENTAGES OF UNDERGRADUATE STUDENTS WHO VISITED	PERCENTAGES OF MATHEMATICS MAJORS WHO VISITED
FALL 2008	24%*	20%**
SPRING 2009	35%*	31%**
FALL 2009	29%*	52%**
SPRING 2010	30%*	44%**

*Based on the total number of undergraduate students enrolled in mathematics classes per semester (Fall 2008- Spring 2010).
**Based on the TWU Factbook's total number of mathematics majors enrolled per semester.
Note that TWU has three campuses: Denton, Dallas and Houston. The numbers used in this table are the Denton campus numbers only since MTSC is locally found in the Denton campus.

Figure 1: Mathematics Tutoring at MTSC

4.2 Mathematics courses and number of mathematics majors who availed of tutoring services

In order to get a better picture of mathematics tutoring done at TWU, we checked the number of mathematics majors needing tutoring per course offered per semester. Table 2 lists mathematics courses, total number of mathematics majors tutored, total number of visits and total hours spent. Based on the last row of Table 2, there is an apparent increase in number of students, number of visits, and number of hours spent in the tutoring centre. We do not know whether this is because of the (1) better way of tracking students, (2) better tutoring centre venue (there was a room change), (3) improved advertisement via Student Support Services or professors, (4) increased number of assignment from professors, or (5) student motivation to learn important concepts. The future study will be geared towards collecting data to measure which of these factors mentioned above are reasons for students visiting the tutoring centre.

Table 2. List of Mathematics Courses and Mathematics Majors Needing Tutoring Services

COURSES MATH MAJORS NEED HELP WITH	NUMBER OF MATH MAJORS WHO VISITED				NUMBER OF VISITS				TOTAL NUMBER OF HOURS			
SEMESTERS	FA08	SP09	FA09	SP10	FA08	SP09	FA09	SP10	FA08	SP09	FA09	SP10
Quantitative Literacy	2	3	3	#	4	7	18	#	2.8	11.4	16.6	#
College Algebra	#	#	#	4	#	#	#	8	#	#	#	23.9
Trigonometry	1	2	3	2	3	12	42	10	3.5	18.1	69	17
Analytic Geometry	3	*	7	*	37	*	52	*	39.6	*	80.8	*
Elementary Statistics I	3	1	1	4	7	1	1	66	7.6	2.4	0.25	59.2
Elementary Statistics II	#	#	#	#	#	#	#	#	#	#	#	#
Calculus I	3	2	6	5	16	37	46	104	21.5	79.3	75.3	198
Calculus II	*	6	*	4	*	40	*	35	*	50.5	*	49
Calculus III	2	*	14	*	8	*	93	*	6.1	*	161.3	*
Discrete Mathematics	*	#	*	3	*	#	*	20	*	#	*	48.4
Abstract Algebra	7	8	9	18	93	47	55	192	106.2	78	87.8	305
Linear Algebra	2	*	4	*	13	*	35	*	13.8	*	47.6	*
Matrix Methods	*	7	*	7	*	67	*	46	*	87.1	*	74
Differential Equations	*	3	*	*	*	35	*	*	*	55.7	*	*
Probability and Statistics	2	*	10	1	20	*	109	7	17.5	*	150.6	16.5
TOTAL	**25**	**32**	**57**	**48**	**197**	**239**	**433**	**361**	**216**	**371**	**673**	**767**

* not offered
# offered but nobody came

4.3 Comparison of Course Grades of Mathematics Majors who visited and did not visit MTSC.

In order to measure whether tutoring has a positive effect on student grades, we focused on two courses (Calculus I and Abstract Algebra). Grades of all students in these courses (students who visited and who did not) were "mathematicized". The grades of "A", "B", "C", "D", and "F" were given weights of "4", "3", "2", "1", and "0", respectively. Table 3 indicates that there is no significant difference in grades of mathematics majors who visited and did not visit.

Table 3. Mean Number of Visits, Total Number of Hours Spent in MTSC for Two Mathematics Courses and Mathematics Majors Needing Tutoring

MATH MAJORS TAKING (Fall 2008-Spring 2010)	Mean # OF VISITS	Mean # OF HOURS SPENT	Average GRADE
CALCULUS I (n =16)	12.69	24.84	2.31
ABSTRACT ALGEBRA (n = 43)	9.21	13.73	2.19

NO MTSC USAGE	Mean # OF VISITS	Mean # OF HOURS SPENT	Average GRADE
CALCULUS I (n =18)	0	0	2.33
ABSTRACT ALGEBRA (n =16)	0	0	2.25

4.4 Relationship between Course Grades of Mathematics Majors and Number of Hours Spent in MTSC

The authors decided that the data of the past four semesters would be adequate to check the relationship between numbers of hours spent in MTSC for tutoring by mathematics majors and course grades obtained in mathematics classes tutored in. The values of *r* in Table 4 do not show any strong correlation between number of hours spent in MTSC and course grades in the course tutored in.

Table 4. Correlation Coefficient: Total Number of Hours Spent in MTSC for Two Mathematics Courses of Mathematics Majors and Grades

CLASS	CORRELATION COEFFICIENT (*r*)
CALCULUS I	0.26
ABSTRACT ALGEBRA	0.14

5. Conclusion

The claim that "one-on-one tutoring is effective" is not at all showing in this study. The calculations did not show any difference in grades of students who availed of MTSC tutoring service and students who did not. One question that comes to mind is: Had these students not visited MTSC, would the grades be lower compared to those who did not visit at all? Most of these mathematics majors taking the same class tend to form a cohort and answer exercises together in the MTSC. There is a need to gather data in order to assess student improvement after a fixed number of MTSC visits. Collaborative effort and cooperation from course instructors may aid in identifying tutoring efficacy. In a subtle way, this research study strengthens the claim that one-on-one tutoring does not have an effect on student success. One might argue that students who do not seek tutoring support understood the lectures. Or it may be the case that those who visited MTSC felt they needed to solve a few more problems to understand the lectures. It is indeed difficult to quantify motivation. The current data does not reveal who sought tutoring for short-term purposes, i.e. solve homework assignments, as opposed to students who were attempting mastery of the topics.

6. Future Work

Hindsight tells us that we should have a way of classifying students who seek tutoring. We plan to continue to collect the same set of data plus other information which will broaden our understanding of student motivation and needs. A more extensive database may illuminate the types of relationships between academic student support services and final grades, thereby pinpointing important factors affecting student success.

References

Boylan, H., & Bonham, B. (2003, October). *Criteria for program evaluation: Establishing the value of what we do*. Paper presented at the meeting of the College Reading and Learning Association, Albuquerque, NM.

Cain, D. & Reynolds, G. (2006). The Impact of Facilities on Recruitment and Retention of Students. *APPA's Centre for Facilities Research Papers 2006*. Retrieved June 21, 2010, from http://www.appa.org/files/FMArticles/fm030406_f7_impact.pdf.

Cooper, E. (2010). Tutoring Centre Effectiveness: The Effect of Drop-In Tutoring. *Journal of College Reading and Learning*, 40(2), Spring 2010.Cooper, E. (2010, Spring).

Higher Education Research Institute (2010) Degrees of success: bachelor's degree completion rates among initial STEM majors. HERI/CIRP Research Brief, January.

Stevenson, H. & Stigler, J. (1997). Learning Gap: Why Our Schools Are Failing and What We Can Learn from Japanese and Chinese Education. *Touchstone, New York, 1992*.

Topping, K. J. (1996). The effectiveness of peer tutoring in further and higher education: a typology and review of the literature. *Higher Education*, 32, 321-345.

Topping, K. J. (2005). Trends in Peer learning. *Educational Psychology*, 25, 631-645.

Hendriksen, I. H. et al, (2005). Assessing Academic Support: The Effects of Tutoring on Student Learning Outcomes. *Journal of Reading and Learning*, 35, 56-65.